#6

SEQUENCE LISTING

<110> Miller, Brian S.
Shetty, Jayarama K.

<120> Modified Forms of Pullulanase

<130> GC396-2

<140> 09/262,126
<141> 1999-03-03

<160> 9

<170> FastSEQ for Windows Version 3.0

<210> 1
<211> 2794
<212> DNA
<213> B. deramificans

<400> 1

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gatcagcttc tgacaaaagg agctcaaaaa ggcatgggag tagcggtgtt taatgacaat 2040

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tcttcaccag gtgagacaat taactatgtc acaagtcatg ataactacac cctttgggac    2220
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gcacaagcag ttgttatgac ctcacaaggc gttccattca tgcaaggcgg ggaagaaatg    2340
cttcgtanaa aaggcggcaa cgacaatagt tataatgcag gcgatgcggt caatgagttt    2400
gattggagca ggaaagctca atatccagat gttttcaact attatagcgg gctaatccac    2460
cttcgtcttg atcacccagc cttccgcatg acgacagcta atgaaatcaa tagccacctc    2520
caattcctaa atagtccaga gaacacagtg gcctatgaat taactgatca tgttaataaa    2580
gacaaatggg gaaatatcat tgttgtttat aacccaaata aaactgtagc aaccatcaat    2640
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ggtcaagcag agggaagtgt ccaagtacca ggtatatcta tgatgatcct tcatcaagag    2760
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<213> B. deramificans

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Thr Thr Thr Ile Ile Val His Tyr Phe Cys Pro Ala Gly Asp Tyr Gln
        35                  40                  45
Pro Trp Ser Leu Trp Met Trp Pro Lys Asp Gly Gly Gly Ala Glu Tyr
    50                  55                  60
Asp Phe Asn Gln Pro Ala Asp Ser Phe Gly Ala Val Ala Ser Ala Asp
65                  70                  75                  80
Ile Pro Gly Asn Pro Ser Gln Val Gly Ile Ile Val Arg Thr Gln Asp
                85                  90                  95
Trp Thr Lys Asp Val Ser Ala Asp Arg Tyr Ile Asp Leu Ser Lys Gly
            100                 105                 110
Asn Glu Val Trp Leu Val Glu Gly Asn Ser Gln Ile Phe Tyr Asn Glu
        115                 120                 125
Lys Asp Ala Glu Asp Ala Ala Lys Pro Ala Val Ser Asn Ala Tyr Leu
    130                 135                 140
Asp Ala Ser Asn Gln Val Leu Val Lys Leu Ser Gln Pro Leu Thr Leu
145                 150                 155                 160
Gly Glu Gly Xaa Ser Gly Phe Thr Val His Asp Asp Thr Ala Asn Lys
                165                 170                 175
Asp Ile Pro Val Thr Ser Val Lys Asp Ala Ser Leu Gly Gln Asp Val
            180                 185                 190
Thr Ala Val Leu Ala Gly Thr Phe Gln His Ile Phe Gly Gly Ser Asp
        195                 200                 205
Trp Ala Pro Asp Asn His Ser Thr Leu Leu Lys Lys Val Thr Asn Asn
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210 215 220
Leu Tyr Gln Phe Ser Gly Asp Leu Pro Glu Gly Asn Tyr Gln Tyr Lys
225 230 235 240
Val Ala Leu Asn Asp Ser Trp Asn Asn Ser Tyr Pro Ser Asp Asn Ile
245 250 255
Asn Leu Thr Val Pro Ala Gly Gly Ala His Val Thr Phe Ser Tyr Ile
260 265 270
Pro Ser Thr His Ala Val Tyr Asp Thr Ile Asn Asn Pro Asn Ala Asp
275 280 285
Leu Gln Val Glu Ser Gly Val Lys Thr Asp Leu Val Thr Val Thr Leu
290 295 300
Gly Glu Asp Pro Asp Val Ser His Thr Leu Ser Ile Gln Thr Asp Gly
305 310 315 320
Tyr Gln Ala Lys Gln Val Ile Pro Arg Asn Val Leu Asn Ser Ser Gln
325 330 335
Tyr Tyr Tyr Ser Gly Asp Asp Leu Gly Asn Thr Tyr Thr Gln Lys Ala
340 345 350
Thr Thr Phe Lys Val Trp Ala Pro Thr Ser Thr Gln Val Asn Val Leu
355 360 365
Leu Tyr Asp Ser Ala Thr Gly Ser Val Thr Lys Ile Val Pro Met Thr
370 375 380
Ala Ser Gly His Gly Val Trp Glu Ala Thr Val Asn Gln Asn Leu Glu
385 390 395 400
Asn Trp Tyr Tyr Met Tyr Glu Val Thr Gly Gln Gly Ser Thr Arg Thr
405 410 415
Ala Val Asp Pro Tyr Ala Thr Ala Ile Ala Pro Asn Gly Thr Arg Gly
420 425 430
Met Ile Val Asp Leu Ala Lys Thr Asp Pro Ala Gly Trp Asn Ser Asp
435 440 445
Lys His Ile Thr Pro Lys Asn Ile Glu Asp Glu Val Ile Tyr Glu Met
450 455 460
Asp Val Arg Asp Phe Ser Ile Asp Pro Asn Ser Gly Met Lys Asn Lys
465 470 475 480
Gly Lys Tyr Leu Ala Leu Thr Glu Lys Gly Thr Lys Gly Pro Asp Asn
485 490 495
Val Lys Thr Gly Ile Asp Ser Leu Lys Gln Leu Gly Ile Thr His Val
500 505 510
Gln Leu Met Pro Val Phe Ala Ser Asn Ser Val Asp Glu Thr Asp Pro
515 520 525
Thr Gln Asp Asn Trp Gly Tyr Asp Pro Arg Asn Tyr Asp Val Pro Glu
530 535 540
Gly Gln Tyr Ala Thr Asn Ala Asn Gly Asn Ala Arg Ile Lys Glu Phe
545 550 555 560
Lys Glu Met Val Leu Ser Leu His Arg Glu His Ile Gly Val Asn Met
565 570 575
Asp Val Val Tyr Asn His Thr Phe Ala Thr Gln Ile Ser Asp Phe Asp
580 585 590
Lys Ile Val Pro Glu Tyr Tyr Tyr Arg Thr Met Ile Gln Val Ile Ile
595 600 605
Pro Thr Asp Gln Val Leu Glu Met Lys Leu Xaa Ala Glu Arg Pro Met
610 615 620
Val Gln Lys Phe Ile Ile Asp Ser Leu Lys Tyr Trp Val Asn Glu Tyr
625 630 635 640
His Ile Asp Gly Phe Arg Phe Asp Leu Met Ala Leu Leu Gly Lys Asp
645 650 655
Thr Met Ser Lys Ala Ala Ser Glu Leu His Ala Ile Asn Pro Gly Ile
660 665 670

Ala Leu Tyr Gly Glu Pro Trp Thr Gly Gly Thr Ser Ala Leu Pro Asp
675 680 685
Asp Gln Leu Leu Thr Lys Gly Ala Gln Lys Gly Met Gly Val Ala Val
690 695 700
Phe Asn Asp Asn Leu Arg Asn Ala Leu Asp Gly Asn Val Phe Asp Ser
705 710 715 720
Ser Ala Gln Gly Phe Ala Thr Gly Ala Thr Gly Leu Thr Asp Ala Ile
725 730 735
Lys Asn Gly Val Glu Gly Ser Ile Asn Asp Phe Thr Ser Ser Pro Gly
740 745 750
Glu Thr Ile Asn Tyr Val Thr Ser His Asp Asn Tyr Thr Leu Trp Asp
755 760 765
Lys Ile Ala Leu Ser Asn Pro Asn Asp Ser Glu Ala Asp Arg Ile Lys
770 775 780
Met Asp Glu Leu Ala Gln Ala Val Val Met Thr Ser Gln Gly Val Pro
785 790 795 800
Phe Met Gln Gly Gly Glu Glu Met Leu Arg Xaa Lys Gly Gly Asn Asp
805 810 815
Asn Ser Tyr Asn Ala Gly Asp Ala Val Asn Glu Phe Asp Trp Ser Arg
820 825 830
Lys Ala Gln Tyr Pro Asp Val Phe Asn Tyr Tyr Ser Gly Leu Ile His
835 840 845
Leu Arg Leu Asp His Pro Ala Phe Arg Met Thr Thr Ala Asn Glu Ile
850 855 860
Asn Ser His Leu Gln Phe Leu Asn Ser Pro Glu Asn Thr Val Ala Tyr
865 870 875 880
Glu Leu Thr Asp His Val Asn Lys Asp Lys Trp Gly Asn Ile Ile Val
885 890 895
Val Tyr Asn Pro Asn Lys Thr Val Ala Thr Ile Asn Leu Pro Ser Gly
900 905 910
Lys Trp Ala Ile Asn Ala Thr Ser Gly Lys Val Gly Glu Ser Thr Leu
915 920 925
Gly Gln Ala Glu Gly Ser Val Gln Val Pro Gly Ile Ser Met Met Ile
930 935 940
Leu His Gln Glu Val Ser Pro Asp His Gly Lys Lys Xaa Lys
945 950 955

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<213> B. subtilis

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20 25 30
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35 40 45
Glu Glu Tyr Ser Leu Glu Ala Lys Tyr Lys Tyr Val Cys Val Ser Asp
50 55 60
His Pro Val Thr Phe Gly Lys Ile His Cys Val Arg Ala Ser Ser Gly
65 70 75 80
His Lys Thr Asp Leu Gln Ile Gly Ala Val Ile Arg Thr Ala Ala Phe
85 90 95
Asp Asp Glu Phe Tyr Tyr Asp Gly Glu Leu Gly Ala Val Tyr Thr Ala
100 105 110

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Asp His Thr Val Phe Lys Val Trp Ala Pro Ala Ala Thr Ser Ala Ala
        115                 120                 125
Val Lys Leu Ser His Pro Asn Lys Ser Gly Arg Thr Phe Gln Met Thr
    130                 135                 140
Arg Leu Glu Lys Gly Val Tyr Ala Val Thr Val Thr Gly Asp Leu His
145                 150                 155                 160
Gly Tyr Glu Tyr Leu Phe Cys Ile Cys Asn Asn Ser Glu Trp Met Glu
                165                 170                 175
Thr Val Asp Gln Tyr Ala Lys Ala Val Thr Val Asn Gly Glu Lys Gly
            180                 185                 190
Val Val Leu Arg Pro Asp Gln Met Lys Trp Thr Ala Pro Leu Lys Pro
        195                 200                 205
Phe Ser His Pro Val Asp Ala Val Ile Tyr Glu Thr His Leu Arg Asp
    210                 215                 220
Phe Ser Ile His Glu Asn Ser Gly Met Ile Asn Lys Gly Lys Tyr Leu
225                 230                 235                 240
Ala Leu Thr Glu Thr Asp Thr Gln Thr Ala Asn Gly Ser Ser Ser Gly
                245                 250                 255
Leu Ala Tyr Val Lys Glu Leu Gly Val Thr His Val Glu Leu Leu Pro
            260                 265                 270
Val Asn Asp Phe Ala Gly Val Asp Glu Glu Lys Pro Leu Asp Ala Tyr
        275                 280                 285
Asn Trp Gly Tyr Asn Pro Leu His Phe Phe Ala Pro Glu Gly Ser Tyr
    290                 295                 300
Ala Ser Asn Pro His Asp Pro Gln Thr Arg Lys Thr Glu Leu Lys Gln
305                 310                 315                 320
Met Ile Asn Thr Leu His Gln His Gly Leu Arg Val Ile Leu Asp Val
                325                 330                 335
Val Phe Asn His Val Tyr Lys Arg Glu Asn Ser Pro Phe Glu Lys Thr
            340                 345                 350
Val Pro Gly Tyr Phe Phe Arg His Asp Glu Cys Gly Met Pro Ser Asn
        355                 360                 365
Gly Thr Gly Val Gly Asn Asp Ile Ala Ser Glu Arg Arg Met Ala Arg
    370                 375                 380
Lys Phe Ile Ala Asp Cys Val Val Tyr Trp Leu Glu Glu Tyr Asn Val
385                 390                 395                 400
Asp Gly Phe Arg Phe Asp Leu Leu Gly Ile Leu Asp Ile Asp Thr Val
                405                 410                 415
Leu Tyr Met Lys Glu Lys Ala Thr Lys Ala Lys Pro Gly Ile Leu Leu
            420                 425                 430
Phe Gly Glu Gly Trp Asp Leu Ala Thr Pro Leu Pro His Glu Gln Lys
        435                 440                 445
Ala Ala Leu Ala Asn Ala Pro Arg Met Pro Gly Ile Gly Phe Phe Asn
    450                 455                 460
Asp Met Phe Arg Asp Ala Val Lys Gly Asn Thr Phe His Leu Lys Ala
465                 470                 475                 480
Thr Gly Phe Ala Leu Gly Asn Gly Glu Ser Ala Gln Ala Val Met His
                485                 490                 495
Gly Ile Ala Gly Ser Ser Gly Trp Lys Ala Leu Ala Pro Ile Val Pro
            500                 505                 510
Glu Pro Ser Gln Ser Ile Asn Tyr Val Glu Ser His Asp Asn His Thr
        515                 520                 525
Phe Trp Asp Lys Met Ser Phe Ala Leu Pro Gln Glu Asn Asp Ser Arg
    530                 535                 540
Lys Arg Ser Arg Gln Arg Leu Ala Val Ala Ile Ile Leu Leu Ala Gln
545                 550                 555                 560
Gly Val Pro Phe Ile His Ser Gly Gln Glu Phe Phe Arg Thr Lys Gln
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565 570 575
Gly Val Glu Asn Ser Tyr Gln Ser Ser Asp Ser Ile Asn Gln Leu Asp
580 585 590
Trp Asp Arg Arg Glu Thr Phe Lys Glu Asp Val His Tyr Ile Arg Arg
595 600 605
Leu Ile Ser Leu Arg Lys Ala His Pro Ala Phe Arg Leu Arg Ser Ala
610 615 620
Ala Asp Ile Gln Arg His Leu Glu Cys Leu Thr Leu Lys Glu His Leu
625 630 635 640
Ile Ala Tyr Arg Leu Tyr Asp Leu Asp Glu Val Asp Glu Trp Lys Asp
645 650 655
Ile Ile Val Ile His His Ala Ser Pro Asp Ser Val Glu Trp Arg Leu
660 665 670
Pro Asn Asp Ile Pro Tyr Arg Leu Leu Cys Asp Pro Ser Gly Phe Gln
675 680 685
Glu Asp Pro Thr Glu Ile Lys Lys Thr Val Ala Val Asn Gly Ile Gly
690 695 700
Thr Val Ile Leu Tyr Leu Ala Ser Asp Leu Lys Ser Phe Ala
705 710 715

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<211> 1091
<212> PRT
<213> K. pneumonia

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35 40 45
Ala Val Pro Gly Glu Ala Val Thr Ala Val Glu Asn Gln Ala Val Ile
50 55 60
His Leu Val Asp Ile Ala Gly Ile Thr Ser Ser Ser Ala Ala Asp Tyr
65 70 75 80
Ser Ser Lys Asn Leu Tyr Leu Trp Asn Asn Glu Thr Cys Asp Ala Leu
85 90 95
Ser Ala Pro Val Ala Asp Trp Asn Asp Val Ser Thr Thr Pro Ser Gly
100 105 110
Ser Asp Lys Tyr Gly Pro Tyr Trp Val Ile Pro Leu Asn Lys Glu Ser
115 120 125
Gly Cys Ile Asn Val Ile Val Arg Asp Gly Thr Asp Lys Leu Ile Asp
130 135 140
Ser Asp Leu Arg Val Ala Phe Gly Asp Phe Thr Asp Arg Thr Val Ser
145 150 155 160
Val Ile Ala Gly Asn Ser Ala Val Tyr Asp Ser Arg Ala Asp Ala Phe
165 170 175
Arg Ala Ala Phe Gly Val Ala Leu Ala Glu Ala His Trp Val Asp Lys
180 185 190
Asn Thr Leu Leu Trp Pro Gly Gly Gln Asp Lys Pro Ile Val Arg Leu
195 200 205
Tyr Tyr Ser His Ser Ser Lys Val Ala Ala Asp Gly Glu Gly Lys Phe
210 215 220
Thr Asp Arg Tyr Leu Lys Leu Thr Pro Thr Thr Val Ser Gln Gln Val
225 230 235 240
Ser Met Arg Phe Pro His Leu Ser Ser Tyr Ala Ala Phe Lys Leu Pro

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Ala Gly Val Leu Asp Asp Ala Tyr Ala Glu Ala Ala Glu Ala Leu Ser
    290                 295                 300
Tyr Gly Ala Gln Leu Ala Asp Gly Gly Val Thr Phe Arg Val Trp Ala
305                 310                 315                 320
Pro Thr Ala Gln Gln Val Asp Val Val Val Tyr Ser Ala Asp Lys Lys
                325                 330                 335
Val Ile Gly Ser His Pro Met Thr Arg Asp Ser Ala Ser Gly Ala Trp
            340                 345                 350
Ser Trp Gln Gly Gly Ser Asp Leu Lys Gly Ala Phe Tyr Arg Tyr Ala
        355                 360                 365
Met Thr Val Tyr His Pro Gln Ser Arg Lys Val Glu Gln Tyr Glu Val
    370                 375                 380
Thr Asp Pro Tyr Ala His Ser Leu Ser Thr Asn Ser Glu Tyr Ser Gln
385                 390                 395                 400
Val Val Asp Leu Asn Asp Ser Ala Leu Lys Pro Asp Gly Trp Asp Asn
                405                 410                 415
Leu Thr Met Pro His Ala Gln Lys Thr Lys Ala Asp Leu Ala Lys Met
            420                 425                 430
Thr Ile His Glu Ser His Ile Arg Asp Leu Ser Ala Trp Asp Gln Thr
        435                 440                 445
Val Pro Ala Glu Leu Arg Gly Lys Tyr Leu Ala Leu Thr Ala Gly Asp
    450                 455                 460
Ser Asn Met Val Gln His Leu Lys Thr Leu Ser Ala Ser Gly Val Thr
465                 470                 475                 480
His Val Glu Leu Leu Pro Val Phe Asp Leu Ala Thr Val Asn Glu Phe
                485                 490                 495
Ser Asp Lys Val Ala Asp Ile Gln Gln Pro Phe Ser Arg Leu Cys Glu
            500                 505                 510
Val Asn Ser Ala Val Lys Ser Ser Glu Phe Ala Gly Tyr Cys Asp Ser
        515                 520                 525
Gly Ser Thr Val Glu Glu Val Leu Asn Gln Leu Lys Gln Ser Asp Ser
    530                 535                 540
Gln Asp Asn Pro Gln Val Gln Ala Leu Asn Thr Leu Val Ala Gln Thr
545                 550                 555                 560
Asp Ser Tyr Asn Trp Gly Tyr Asp Pro Phe His Tyr Thr Val Pro Glu
                565                 570                 575
Gly Ser Tyr Ala Thr Asp Pro Glu Gly Thr Thr Arg Ile Lys Glu Phe
            580                 585                 590
Arg Thr Met Ile Gln Ala Ile Lys Gln Asp Leu Gly Met Asn Val Ile
        595                 600                 605
Met Asp Val Val Tyr Asn His Thr Asn Ala Ala Gly Pro Thr Asp Arg
    610                 615                 620
Thr Ser Val Leu Asp Lys Ile Val Pro Trp Tyr Tyr Gln Arg Leu Asn
625                 630                 635                 640
Glu Thr Thr Gly Ser Val Glu Ser Ala Thr Cys Cys Ser Asp Ser Ala
                645                 650                 655
Pro Glu His Arg Met Phe Ala Lys Leu Ile Ala Asp Ser Leu Ala Val
            660                 665                 670
Trp Thr Thr Asp Tyr Lys Ile Asp Gly Phe Arg Phe Asp Leu Met Gly
        675                 680                 685
Tyr His Pro Lys Ala Gln Ile Leu Ser Ala Trp Glu Arg Ile Lys Ala
    690                 695                 700
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Leu Asn Pro Asp Ile Tyr Phe Phe Gly Glu Gly Trp Asp Ser Asn Gln
705                 710                 715                 720
Ser Asp Arg Phe Glu Ile Ala Ser Gln Ile Asn Leu Lys Gly Thr Gly
                725                 730                 735
Ile Gly Thr Phe Ser Asp Arg Leu Arg Asp Ser Val Arg Gly Gly Gly
            740                 745                 750
Pro Phe Asp Ser Gly Asp Ala Leu Arg Gln Asn Gln Gly Ile Gly Ser
        755                 760                 765
Gly Ala Gly Val Leu Pro Asn Glu Leu Ala Ser Leu Ser Asp Asp Gln
    770                 775                 780
Val Arg His Leu Ala Asp Leu Thr Arg Leu Gly Met Ala Gly Asn Leu
785                 790                 795                 800
Ala Asp Phe Val Met Ile Asp Lys Asp Gly Ala Ala Lys Lys Gly Ser
                805                 810                 815
Glu Ile Asp Tyr Asn Gly Ala Pro Gly Gly Tyr Ala Ala Asp Pro Thr
            820                 825                 830
Glu Val Val Asn Tyr Val Ser Lys His Asp Asn Gln Thr Leu Trp Asp
        835                 840                 845
Met Ile Ser Tyr Lys Ala Ser Gln Glu Ala Asp Leu Ala Thr Arg Val
    850                 855                 860
Arg Met Gln Ala Val Ser Leu Ala Thr Val Met Leu Gly Gln Gly Ile
865                 870                 875                 880
Ala Phe Asp Gln Gln Gly Ser Glu Leu Leu Arg Ser Lys Ser Phe Thr
                885                 890                 895
Arg Asp Ser Tyr Asp Ser Gly Asp Trp Phe Asn Arg Val Asp Tyr Ser
            900                 905                 910
Leu Gln Asp Asn Asn Tyr Asn Val Gly Met Pro Arg Ile Ser Asp Asp
        915                 920                 925
Gly Ser Asn Tyr Glu Val Ile Thr Arg Val Lys Glu Met Val Ala Thr
    930                 935                 940
Pro Gly Glu Ala Glu Leu Lys Gln Met Thr Ala Phe Tyr Gln Glu Leu
945                 950                 955                 960
Thr Glu Leu Arg Lys Ser Ser Pro Leu Phe Thr Leu Gly Asp Gly Ser
                965                 970                 975
Ala Val Met Lys Arg Val Asp Phe Arg Asn Thr Gly Ser Asp Gln Gln
            980                 985                 990
Ala Gly Leu Leu Val Met Thr Val Asp Asp Gly Met Lys Ala Gly Ala
        995                 1000                1005
Ser Leu Asp Ser Arg Leu Asp Gly Leu Val Val Ala Ile Asn Ala Ala
    1010                1015                1020
Pro Glu Ser Arg Thr Leu Asn Glu Phe Ala Gly Glu Thr Leu Gln Leu
1025                1030                1035                104
Ser Ala Ile Gln Gln Thr Ala Gly Glu Asn Ser Leu Ala Asn Gly Val
                1045                1050                1055
Gln Ile Ala Ala Asp Gly Thr Val Thr Leu Pro Ala Trp Ser Val Ala
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Ser Ser Lys
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<223> Unknown

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